

FIG. 1

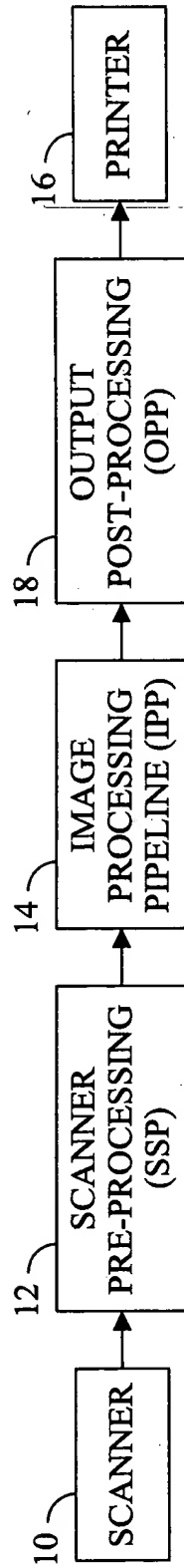


FIG. 2

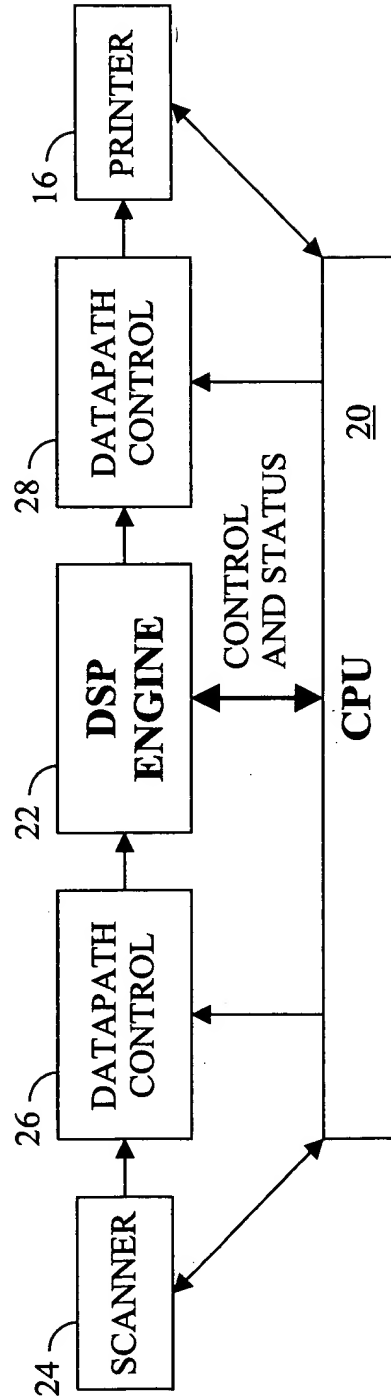


FIG. 3

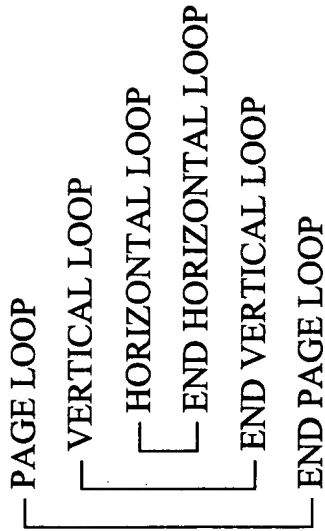


FIG. 4

```

For each output page {
  For each vertical clone {
    Scan the input document
    For each RGB scanline {
      Process the scanline with IPP
      For each resulting CMYK binary scanline {

```

```

// Call OPP with CTP mode
If horizontal cloning is desired
  Generate the required number of horizontal clones
If mirroring is desired
  reverse the scanline

```

```

      }
    }
  }
}

```

FIG. 5

```
Scan the input document
For each RGB scanline {
    Process the scanline with IPP
    For each resulting CMYK binary scanline {
        // Call OPP with CTP mode
        Store each resulting scanline in memory
    }
}
For each page {
    // Call OPP with PFM mode
    For each vertical clone {
        For each CMYK binary scanline in memory {
            Retrieve scanline from memory
            If horizontal cloning is desired
                Generate the required number of horizontal clones
            If mirroring is desired
                reverse the scanline
        }
    }
}
```

FIG. 6

Task OPP {

```
// This is where OPP's execution starts the first time it is called.  
// Initialize all necessary buffer space, variables, and registers.  
L = CurrentLine = NumOPPLines;  
N = CurrentVerClone = NumVertClones;  
EncodedSizeCount = 0;  
GlobalCompBufPointer = GlobalCompBufStart;  
VertClonePadLinesToDo = 0;
```

TASK_LOOP:

```
// The following SUSPEND causes control to return to the executive  
// (outermost) loop, which calls each of the tasks in a round-robin fashion.  
// Any or all of OPP's "local" state (registers, variables, buffers etc.) could  
// be overwritten by the executive and/or by other tasks, while OPP is suspended.  
// In the implementation, any state that must persist while OPP is suspended  
// (e.g., state flags, buffer pointers, counts, etc.) must be explicitly saved in  
// global (off-chip) memory before SUSPEND, and restored before use after  
// return from SUSPEND. For clarity of presentation, these save/restore  
// operations are not explicitly shown in this pseudocode.
```

SUSPEND (&OPPReturnAddress);

```
// Execution resumes here, each time (except for the very first time) that  
// the executive round-robin loop yields control back to OPP.  
// Check OPP's "idle" flag, and skip polling if cleared.  
if (!IDLE) goto ACTIVATE_OPP;  
// Poll for OPP Activate message from CPU, and clear idle flag if received.  
// If CPU has not sent us an Activate message, then loop back to suspend  
// and give other microcode tasks a chance to run.
```

FIG. 7A

```
CheckForCPUMessage (Message, Status);
if (Status == MESSAGE_NOT_RECEIVED)    goto TASK_LOOP;
if (Message != OPP_ACTIVATE)          goto TASK_LOOP;
IDLE = 0;

ACTIVATE_OPP:
    // Check for free output buffer, unless storing.
    if (DO_STORE && !DO_DECODE)    goto NO_OUTPUT_OK;
    // Loop back and suspend if insufficient output buffer space is available
    // to hold a complete CMYK line in printer format. Note that a separate
    // output DMA task is responsible for removing data from OPP's output
    // buffer and for sending it on to the printer.
    if (!BufferFree (OPPOutBuf))    goto TASK_LOOP;
    // Output buffer space is available. If we now need to output any
    // inter-vertical-clone pad lines, then output one now, update count of
    // pad lines remaining to be output, loop back and suspend.
    if (VertClonePadLinesToDo == 0)    goto NO_OUTPUT_OK;
    SetToWhite (OPPOutBuf);
    --VertClonePadLinesToDo;
    goto OUTPUT_CMYK_LINE;

NO_OUTPUT_OK:
    // Permit decode play out even with no input.
    if (DO_DECODE)    goto ENCODE_DONE;
    // Check for full Cyan, Magenta, Yellow, and Black input buffers.
    // These would have been filled by IPP, and live in global memory.
```

FIG. 7B

```
if (!BufferFull (CyanInBuf))      goto TASK_LOOP;
if (!BufferFull (MagentaInBuf))   goto TASK_LOOP;
if (!BufferFull (YellowInBuf))    goto TASK_LOOP;
if (!BufferFull (BlackInBuf))     goto TASK_LOOP;

// Get local copies of the Cyan, Magenta, Yellow, and Black input
// buffers, and mark the space in global memory as empty, allowing
// IPP to place additional data there.
GetBuf (CyanInBuf, LocalCyanBuf);
GetBuf (MagentaInBuf, LocalMagentaBuf);
GetBuf (YellowInBuf, LocalYellowBuf);
GetBuf (BlackInBuf, LocalBlackBuf);

// Encode and measure compressed size if the mode demands it;
// otherwise permit copy through to the printer.
if (!DO_ENCODE) goto ENCODE_DONE;

// Set up encoder and pointer to local compression buffer.
LocalCompBufPointer = LocalCompBufStart;
LocalSizeCount = 0;

// Call a bitonal compression algorithm to encode each of the Cyan,
// Magenta, Yellow, and Black inputs, one at a time, into the local
// compression buffer. Each Encode operation conceptually advances the
// LocalCompBufPointer to the next free location past the thus-far-encoded
// region, and updates the local-memory variable LocalSizeCount.
Encode (LocalCyanBuf,   &LocalCompBufPointer, &LocalSizeCount);
Encode (LocalMagentaBuf, &LocalCompBufPointer, &LocalSizeCount);
Encode (LocalYellowBuf,  &LocalCompBufPointer, &LocalSizeCount);
Encode (LocalBlackBuf,   &LocalCompBufPointer, &LocalSizeCount);
```

FIG. 7C

```
// Update the global size-count running total, based on the local one.
EncodedSizeCount += LocalSizeCount;

// Check running total against buffer limit. Note: the buffer limit is sufficiently smaller
// than the actual buffer size, to guarantee that a second scan of the same document
// (which due to noise might compress to a slightly larger size) will also fit within the buffer.
if (EncodedSizeCount < CompressBufLimit) goto COMPRESSED_SIZE_OK;

// Otherwise clear encode flag, and fall back to simple CTP.
DO_ENCODE = 0;

// If we reach here with the store flag set, it is a fatal error! This version
// of OPP need not be equipped to handle a buffer overflow during CTM.
// The expectation is that CME was run successfully first, and there
// is enough pad past the buffer limit so that the buffer can't possibly
// overflow during the second (CTM) scan.
if (DO_STORE) send ERROR message to CPU and ABORT;

COMPRESSED_SIZE_OK:

// Permit play through to printer if we are not storing.
if (!DO_STORE) goto ENCODE_DONE;

// If we're storing, copy the valid portion of the local compression buffer.
// out to the next free region in the global compression buffer. Increment
// the global compression buffer pointer by LocalSizeCount.
CopyBuf (LocalCompBufStart, &GlobalCompBufPointer, LocalSizeCount);

// Disable simultaneous store and print by looping back and suspending.
// Decrement and save input line counter until all input lines are stored.
L = --CurrentLine;
if (L) goto TASK_LOOP;
```

FIG. 7D

```
// Storage finished: reset line count, change state, and loop back to
// relinquish control to the executive. The next time we get control,
// we will be in PFM mode.
DO_ENCODE = 0;
DO_STORE = 0;
DO_DECODE = 1;
L = NumOPPLines;
goto TASK_LOOP;

ENCODE_DONE:
    // Check if we're decoding; if not, play the processed data through to the printer.
    if (!DO_DECODE) goto DECODE_DONE;
    // Bring in one line's worth of CMYK data from the global compression buffer
    // to the local compression buffer. The compressed data format includes embedded
    // size information, so that the number of words that must be copied is determined
    // by inspection of the compressed data.
    // Set up local compression buffer pointer.
    LocalCompBufPointer = LocalCompBufStart;
    // Each copy operation transfers a line's worth of a plane's worth of image data, and
    // advances the global and local compression buffers' pointers based on the record
    // length information embedded in the compressed data.
    // copy cyan record
    GetCompressedData (&GlobalCompBufPointer, &LocalCompBufPointer);
    // copy magenta record
    GetCompressedData (&GlobalCompBufPointer, &LocalCompBufPointer);
    // copy yellow record
    GetCompressedData (&GlobalCompBufPointer, &LocalCompBufPointer);
```

FIG. 7E


```
// copy black record
GetCompressedData (&GlobalCompBufPointer, &LocalCompBufPointer);

// Decode (decompress) a line each of C, M, Y and K from the local compression
// buffer to the local C, M, Y and K buffers. Each Decode operation advances the local
// compression buffer pointer to the next free location in the local compression buffer.
LocalCompBufPointer = LocalCompBufStart;
Decode (&LocalCompBufPointer, LocalCyanBuf);
Decode (&LocalCompBufPointer, LocalMagentaBuf);
Decode (&LocalCompBufPointer, LocalYellowBuf);
Decode (&LocalCompBufPointer, LocalBlackBuf);

// Decrement and save input line counter until all input lines have been decoded.
L = -- CurrentLine;
if (L) goto DECODE_DONE;

// We get here after the last scanline of each vertical clone. Set the number of
// pad lines that must be output next (i.e., between the clone we just completed,
// and the next one, if any). InterCloneVertGap is a system parameter.
VertClonePadLinesToDo = InterCloneVertGap;

// Prepare for the next vertical clone on this page.
// reset line count; decrement and save vertical clone counter
// until all vertical clones have been created.
L = NumOPPLines;
N = --CurrentVertClone;
if (N) goto DECODE_DONE;

// If we're here, we've completed a page. Reset vertical clone count and pad count.
// and set IDLE flag so we will wait for the rest of the system components (output DMA task,
```

FIG. 7F

*// CPU and printer) to finish all their remaining work for this page. Note: The output DMA
// task maintains its own count of the number of lines per page, and it will send a message
// to the CPU after outputting the last line of the current page. The CPU will send an
// Activate message to OPP after all is ready for OPP to begin playing out another page.*

*N = NumVertClones;
VertClonePadLinesToDo = 0;
IDLE = 1;*

DECODE_DONE:

#ifdef THIS_IS_A_DRAFT_PIPELINE

*// Perform 2x horizontal bit replication in place, to convert the horizontal
// sampling rate from that of IPP (300dpi) to that of the printer (600 dpi).*

*Rep2xHorizontal (LocalCyanBuf);
Rep2xHorizontal (LocalMagentaBuf);
Rep2xHorizontal (LocalYellowBuf);
Rep2xHorizontal (LocalBlackBuf);*

#endif

// If the feature is selected, Perform Horizontal Cloning in place on the CMYK buffers.

*if (HorizCloningIsEnabled) {
 HorizClone (LocalCyanBuf, NumHorizClones);
 HorizClone (LocalMagentaBuf, NumHorizClones);
 HorizClone (LocalYellowBuf, NumHorizClones);
 HorizClone (LocalBlackBuf, NumHorizClones);
}*

*// If the feature is selected, Perform Mirroring in place on the CMYK buffers.
if (MirroringIsEnabled) {*

FIG. 7G

```
Mirror(LocalCyanBuf);
Mirror(LocalMagentaBuf);
Mirror(LocalYellowBuf);
Mirror(LocalBlackBuf);
}

// Format the CMYK data as required by the printer.
ConvertFormat (LocalCyanBuf, LocalMagentaBuf, LocalYellowBuf,
               LocalBlackBuf, OPPOutBuf);

OUTPUT_CMYK_LINE:
#ifdef THIS_IS_A_DRAFT_PIPELINE
    // Send the finished image line buffer to the output DMA task, and mark the
    // buffer as full. Output DMA task will empty the buffer when it gets a chance.
    SendBufferToOutput (OPPOutBuf);
    goto TASK_LOOP;
```

FIG. 7H